1,073,078

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,073,078

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COMPLETE SPECIFICATION

Improvements in or relating to Bellows for Protecting Machine-tool Slides

We, ARNOLD HENNIG, of Ismaning bei München, Erlenstrasse 10, Germany, and KURT HENNIG, of München 23, Aachener-Strasse 9, Germany, both German Citizens, trading as GEBRÜDER HENNIG oHG, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The invention relates to bellows of the type used for protecting the sliding tracks of reciprocating parts on machine tools.

The ideal functioning of such bellows requires that the folding edges of the bellows wall material which extend perpendicular to the direction of deployment and are exactly parallel to each other in the collapsed state of the bellows, should retain their parallel disposition and increase their relative distances from each other at approximately uniform rate when the bellows are extended.

In practice, however, it is found that this simple requirement can be satisfied in part only by elaborate constructions that are relatively expensive, and cannot be applied in all cases because of space considerations.

One object of the present invention is to provide a simple bellows construction which approaches this ideal functioning during use.

The invention consists in a bellows for protecting the sliding track of a reciprocating part on a machine tool, in which a supporting tie-piece is provided between two adjacent folding edges of a wall of the bellows, either on the interior or exterior of said wall, said tie-piece having a central fold midway between said folding edges in the same direction as that of the fold in the bellows material between said edges and being made of a sheet material having sufficient stiffness to yieldingly oppose unfolding, the overall length of said tie-piece, measured between said folding edges, being substantially less than the overall length of the bellows wall, measured between said folding edges.

The invention will now be described with reference to the accompanying drawings, in which: —

Figure 1 is a perspective view of one conventional folding arrangement for a bellows;

Figure 2 is a partial perspective view of an alternative conventional folding arrangement for a bellows;

Figure 3 is a side view of the bellows shown in Figure 1, with the folded edges correctly aligned;

Figure 4 is a side view of the bellows shown in Figure 1, showing how the folded edges may become misaligned and convergent, during use;

Figure 5 is a perspective view of the interior wall of one embodiment of a bellows provided with tie-pieces according to the present invention;

Figure 6 is a sectional plan view of the bellows wall shown in Figure 5;

Figure 7 is a similar view with the bellows closed;

Figure 8 is a similar view with the bellows fully extended;

Figure 9 is a similar view showing the end section when fully extended;

Figure 10 is a similar view showing the end section closed;

Figure 11 is a detail view of one tie-piece mounting means;

Figure 12 is a detail perspective view of a tie-piece mounted by the means shown in Figure 11;

Figure 13 is a plan view of the tie-piece mounting shown in Figure 12; and

Figure 14 is a plan view of an alternative tie-piece mounting arrangement.

Deviations from the ideal conditions which are particularly disturbing will be more readily

understood by reference to Figures 1 to 4.

Figure 1 shows a perspective view of a part of a bellows, carried between two supporting riders 10 and 11, disposed in planes transverse to the longitudinal axis of the bellows. Bellows of the form illustrated in Figure 1 are frequently provided with subdividing riders, but for simplicity a simple bellows is shown. This form of bellows is used for protecting horizontally extending sliding tracks of reciprocating parts of machine tools. If a bellows folded as shown in Figure 1 is extended from the completely collapsed state in which the rider 10 and the rider 11 are in close proximity of each other with the material of the bellows folded together, then the ideal functioning stated at the outset requires that the upwardly pointing folding edges 12 must move precisely parallel to each other, in such a manner that the distance between each adjacent pair of folding edges is the same at any degree of extension between the riders 10 and 11. Similarly, the vertical folding edges 13 and 14 on the side facing the observer should also remain precisely parallel to each other, and the relative distances of all folding edges should increase uniformly; in particular, all of the folding edges of the side wall of the bellows facing the observer should remain straight and vertical. In practice, however, this condition is seldom satisfied with the desired degree of precision; it is found rather that when a bellows having the type of folding shown in Figure 1 is extended, the side walls bend (the side facing the observer bending in the direction of the arrow P, as the bellows approach the position of maximum extension. This can constitute a very serious drawback insofar as in this case the internal face of each side wall of the bellows may rub against the sliding tracks of the machine tool and thus suffer damage.

A similar effect to that described above with reference to Figure 1 also occurs with the different type of folding illustrated in Figure 2.

In the type of folding shown in Figure 1, the upwardly pointing folding edges 12 transform on the upper face of the bellows directly into outwardly pointing folding edges 13 on the front wall of the bellows. Between the outwardly pointing folding edges 13 in Figure 1, inwardly pointing folding edges 14 are located. On the other hand, in the type of folding shown in Figure 2, the upwardly pointing folding edges 12 transform on the upper face of the bellows into inwardly pointing folding edges 15 on the side wall of the bellows, and are separated by outwardly pointing folding edges 16.

Experience has shown that when extended a bellows according to Figure 2 exhibits an inverse effect in relation to Figure 1, insofar as the side walls of the bellows bend outwards on approaching the state of maximum deployment, the side wall shown bending outwards in the direction of the arrow Q. Thus, here again we are in the presence of a phenomenon characterised by the fact that the edges 15 and 16, in the central portion of the bellows, cease to be parallel to the corresponding edges at the ends of the section of bellows concerned as the bellows approach full extension.

Another undesirable movement is illustrated in Figures 3 and 4, which show one section of bellows folded in a similar manner to that illustrated in Figure 1, when viewed from the side, *i.e.* perpendicularly to the longitudinal direction of the sliding tracks. The broken lines 17 indicate that to the left of the rider 10 and to the right of the rider 11 the bellows concerned extend in both directions. In the ideal case, as the distance between riders 10 and 11 increases, the bellows folds 13 should always extend precisely vertical, whereas in practice it sometimes happens that one of the riders, *i.e.* for example the right-hand rider, assumes a tilted position, as shown in Figure 4, which of course precludes a precisely vertical position of the folding edges 13 on the front surface of the bellows. Consequently, a tilting of the rider 11 will lead to a deformation of the bellows as indicated in Figure 4, *i.e.* so that the edges 13 converge upwardly on the side of the bellows.

In order to avoid such defects and ensure a parallel positioning of the folds of a bellows and an at least approximately uniform opening of said folds on deployment of the bellows, embodiments of the invention employ a suitable tie-piece between adjacent inner edges of inwardly pointing folding edges or adjacent outer edges of outwardly pointing folding edges. These tie-pieces are made of a sheet material which, though of limited elasticity, is tough and substantially stiff, and are preferably made of the same material as said bellowse. By folding each tie-piece along a line located midway between the adjacent pair of folding edges, the fold itself following the same direction as that of the protective bellows located between these convex folding edges, and employing tie-pieces whose dimensions in the direction perpendicular to the aforementioned folding edges is substantially smaller than that of the associated fold of the protective bellows, when fully extended, the ideal requirements can be substantially satisfied.

In the embodiment of the invention shown in Figure 5, which is a perspective view of the rear side of the bellows not visible in Figure 1, viewed from inside the bellows, the inwardly pointing folding edges 18 stand normal to the horizontal line 19 connecting the lowermost points of the edges 18. The bellows fold 20, which is located between the folds 18 is outwardly pointing, as indicated by the shading of flank wall portions 21 to 24. The

triangle between the lowermost ends of the vertical folding edges 18 and 20 is in a horizontal plane. A tie-piece 25 made of a sheet material which, with regard to its toughness, rigidity and elasticity substantially corresponds to a conventional bellows material, is fastened to the interior of the bellows along the inwardly pointing edges 18. Midway between the inwardly pointing folding edges 18 the sheet 25 is folded along the line 26 in the same direction as the outwardly pointing folding edge 20 of the protective bellows itself.

Accordingly, if the arrangement shown in Figure 5 were to be viewed from above, then the image schematically shown in Figure 6 would be seen, *i.e.* the flanks of the bellows would be seen as a zig-zag line (21 to 24) and the sheet 25 would appear as a line rising from the left and descending, after passing the folding point 26. A more compressed state of the bellows fold shown in Figure 5 would yield the image represented in Figure 7, while in a more extensively deployed state the image illustrated in Figure 8 would be obtained. In Figure 7 the bellows is almost completely collapsed and in Figure 8 it is completely or almost completely deployed, so that the sheet 25 is almost horizontal in the latter case. A complete extension, *i.e.* a precisely horizontal extension of the sheet 25 in Figure 8, is not encountered in practice because the presupposed limited elasticity of its material requires a relatively large force to achieve an extension as great as that indicated in Figure 8.

Although the proposed tie-piece 25 appears to be a surprisingly simple attachment, it has proved to provide a bellows construction which substantially avoids those deviations from a precisely parallel extension of the folding edges and from a uniform deployment of the bellows section concerned which were described with reference to Figures 1 to 4. In the substantially extended position shown in Figure 8, the tensile force exerted by the tie-piece sheet 25 on the adjoining edges 18 restrains the front wall of the bellows to prevent bending in direction of the arrow P or Q (Figures 1 and 2) in a manner similar to the increase of the tension of a washing line acting against the downward pull of the weight of the washing hung on the line.

The increase of the intrinsic elasticity of the bellows from the beginning of the deployment is a further desirable effect produced by the tie-piece sheets according to the invention.

Owing to its stiffness and its relatively large vertical extent, the tie-piece sheet 25 also acts against a change in the shape of the bellows of the type shown in Figure 4, so that a deviation from parallel of the folding edges shown in Figure 4 on deployment is also avoided to a substantial extent. Consequently, the tie-piece sheets should have a large extension in the vertical direction in Figure 5, *i.e.* a so-called large width. The sheets may extend along the whole length of the bellows in almost all cases and, moreover, may be arranged on all side of the bellows. Where tie-pieces are to be provided for two or more adjacent folds, a number of separate tie-piece sheets may be used, or a number of tie-piece sheets can be formed in a single strip extending over a number of folds.

A modified form of tie-piece is required for fixing to the flanks immediately adjacent to a rider, as will now be explained with reference to Figures 9 and 10. Figure 9 shows a horizontal cross-section through the rider 11 of Figure 1 and through the adjoining flanks of that side of the bellows shown in Figure 5, which is not visible in Figure 1, using the same references as in Figure 5. The flanks 21 to 24 are shown in the wholly extended state in Figure 9, for simplicity the sheet 25, 25*a* is drawn as a straight line, but it should be remembered that in fact these sheets will never be so fully extended during normal use.

In the conventional manner, the flank 24 in Figure 9 commences on the outer edge of the rider at the position indicated, *i.e.* on the upper left-hand corner of the shaded cross-section through the rider 11. The end tie-piece sheet 25a associated therewith for the flank 24, which is to have only half the length of a normal tie-piece sheet 25, *i.e.* a length equal to half the distance between the two edges 18 shown in Figure 9, is preferably fastened to the rider 11 along a line, such that in the deployed state of the bellows it comes to lay perpendicular to the plane containing the rider, at least approximately contiguous with sheet 25 in the extended state thereof. Accordingly, the end tie-piece portion 25a of the strip forming the sheet 25 must extend horizontally in Figure 9, and is therefore made fast at a distance from the lower end of the rider cross-section. The folding edge 26a of the sheet 25a is located closer to the rider 11 than to the right-hand folding edge 18.

Figure 10 shows the bellows of Figure 9 in the almost completely collapsed state, and it will be seen that in the collapsed state the edges 18 are level with the lower end of the shaded rider cross-section.

As the bellows shown in the collapsed state in Figure 10 is deployed, the wall flanks as a whole move upwards, during which movement however, the inwardly pointing folding edges 18 shown in Figures 9 and 10 always remain at the same level.

Preferably, in order to effect the fastening of sheet 25a at the distance *h* from the lower end of the rider cross-section, the sheet 25a is clamped under a U-shaped sheet-metal part 27, also shown in cross-section in Figures 9 and 10, which also serves to protect the narrow sides of the rider against wear by

friction on the sliding track or other parts of the machine.

In comparison with the well-known bellows construction, of the "pull-out limiting" type, in which the outwardly pointing folding edges on the upper side of a bellows of the type shown in Figure 1 are interconnected by means of inelastic traction elements in the form of bands extending in the longitudinal direction of the bellows, embodiments of the invention display several advantages. Although these traction elements are capable of forming a rigid stop in the completely deployed state of the bellows to protect against overstretching the bellows material, they are quite unsuitable to counteract an undesirable deformation of the bellows in the sense indicated in Figure 4, for example. Nor would a satisfactory construction be achieved in the case where the known band-shaped traction elements were to be fitted, instead of the sheets 25 in Figure 5 on the inside of the bellows to all folds thereof, because in the folded-up state of the bellows, owing to the folding of each sheet 25 along the line 26, the sheets proposed according to the invention all disappear and fit between the flanks of the protective bellows, whereas when using the known inelastic traction elements, the latter would hang loosely in the form of loops on the inside of the bellows and could only lead to malfunctions. The tie-piece sheets according to the invention, shown in Figure 5, are essentially different in function, as apart from a mere limitation of the extension of a bellows, they also serve to prevent bowing and prevent undesirable deformations of the kind shown in Figure 4.

Alternative methods of fastening a strip forming the tie-piece sheets 25 to the edges 18 are shown in Figures 11 to 14. A very simple fixing is provided by forming tongues 29 from the material of the sheet 25 near the edge, by cutting the bellows material 25 around the free edges of the tongue along the dotted line 28, folding the tongue 29 thereby formed about the composite line 18a which coincides with the line of contact of the sheet 25 with the edge 18, and then cementing said tongue to the flank located underneath This is shown in a perspective view in Figure 12. In this, the sheet 25 is cemented to the flank 22 by means of two tongues 29a and 29b, which are folded around the edge 18, and is thus reliably and pivotably fastened to the edge 18. The number of the tongues employed to effect the fastening of the sheet 25 to the edge 18 may of course be selected at will, according to the conditions prevailing in a given case.

Viewing the arrangement of Figure 12 from above yields the image shown in Figure 13, in which it can be seen that the tongues 29 are swung out of the plane of sheet 25 and are cemented to the flanks 22 or 23.

It needs no further explanation that the next tie piece sheet in a strip which commences on the left-hand one of the edges 18 in Figure 5 and extends to the left over the flank 21, as shown in Figure 11, is provided with tongues in a corresponding manner, which tongues, with regard to their position, may not be identical with the tongues 29a and 29b of Figure 12. Where individual tie-piece sheets are used instead of a strip, the sheet commencing at the left-hand edge 18 in Figure 5 and extending to the left, can and should be connected with sheet 25 on the left-hand edge 18.

Another efficient method of fastening the sheets 25 to the flanks 22 and 23 is shown in Figure 14, in which strips 30, having the same length as the width of the tie-piece in the vertical direction in Figure 5, are cemented over the whole of their length both to the flank 22 or 23 and the sheet 25.

Tie-piece sheets of the type shown in Figure 5 can also be fastened on the outside of the bellows or, if necessary, exclusively on the outside of the bellows.

The invention is not limited to bellows of the kind illustrated in Figures 1 to 4, but can also be applied for example to so-called box-bellows, which may be used to protect vertical columns or sliding tracks on machine tools, and are sometimes referred to as completely closed bellows. Deployment of such a bellows in a vertical direction introduces a further problem—especially in the case of large and heavy bellows—since between the individual frames which replace the riders 11 in these bellows, the bellows folds are not pulled out uniformly, since for example on deployment of the uppermost bellows section the weight of all other bellows sections located underneath and of the frames is also effective. For this reason, in large box-bellows of this kind, trestle-constructions and the like are used to effect uniform deployment of all sections. However, this type of construction is restricted to relatively large box-bellows because of its high cost and space requirements, while for smaller box-bellows a construction which would be satisfactory in all cases was lacking. As stated, the problem in such box-like bellows is primarily one of uniform deployment of the bellows as a whole, *i.e.* a uniform opening of all bellows sections located between two frames each, while the parallel position of the folding edges in relation to each other will be affected only in exceptional circumstances owing to the complete symmetrical form of the bellows, but must nevertheless be ensured on deployment of the latter.

It is already apparent the existing problems can be solved by the use of the bellows according to the invention even in relatively small box-bellows, in which the fitting of trestle guides and the like is not possible. In

such bellows, the uniformity on deployment is improved by the fitting of interior tie-pieces, on two oppositely located sides, for example, since the force required for the deployment of the individual folds is increased and, at the same time, in the almost completely stretched position, the sheets 25 shown in Figure 8 not only achieve a kind of limitation of deployment, but also stabilize the box-bellows against deformation by external, horizontally acting forces, and so reduce the danger of the box-bellows being pressed against the column by an external lateral pressure, as could easily happen if tie-piece sheets were not fitted.

WHAT WE CLAIM IS:—

1. A bellows for protecting the sliding track of a reciprocating part on a machine tool, in which a supporting tie-piece is provided between two adjacent folding edges of a wall of the bellows, either on the interior or exterior of said wall, said tie-piece having a central fold midway between said folding edges in the same direction as that of the fold in the bellows material between said edges and being made of a sheet material having sufficient stiffness to yieldingly oppose unfolding, the overall length of said tie-piece, measured between said folding edges being substantially less than the overall length of the bellows wall, measured between said folding edges.

2. A bellows as claimed in Claim 1, in which a plurality of said tie-pieces are provided, extending over the length of said wall of said bellows.

3. A bellows as claimed in Claim 1 or Claim 2, in which one or more tie-pieces are provided on a plurality of the walls of said bellows.

4. A bellows as claimed in any preceding Claim, in which tie-pieces are provided both between inwardly pointing folding edges on the interior of said bellows and outwardly pointing folding edges on the exterior of said bellows.

5. A bellows as claimed in any preceding Claim, in which said tie-pieces or tie-pieces are made of the same material as the walls of said bellows.

6. A bellows as claimed in any preceding Claim, in which the or each tie-piece is fastened to the wall of said bellows adjacent to said folding edges by tongues formed by cutting said tie-piece around the free edges of the tongues, said tongues then being cemented to said wall.

7. A bellows as claimed in any one of Claims 1 to 5, in which the or each tie-piece is fastened to the wall of said bellows adjacent to said folding edges by means of strips which are cemented over their entire length to both the sheet material of the tie-piece and the wall material of the bellows.

8. A bellows as claimed in Claim 1, in which an end of said bellows is mounted in a rider and at least one wall of said bellows is provided with an end tie-piece between the first fold in said wall and a line on said rider such that, when said bellows are fully extended said end tie-piece lines perpendicular to the plane containing said rider.

9. A bellows as claimed in Claim 8, in which said end tie-piece is clamped to said rider by a U-shaped channel member which surrounds the inner edge of the rider.

10. Bellows for protecting the sliding track of a reciprocating part of a machine tool, substantially as described with reference to Figures 5 to 14 of the accompanying drawings.

11. A machine tool having a reciprocating part whose sliding track is provided with a protective bellows as claimed in any preceding Claim.

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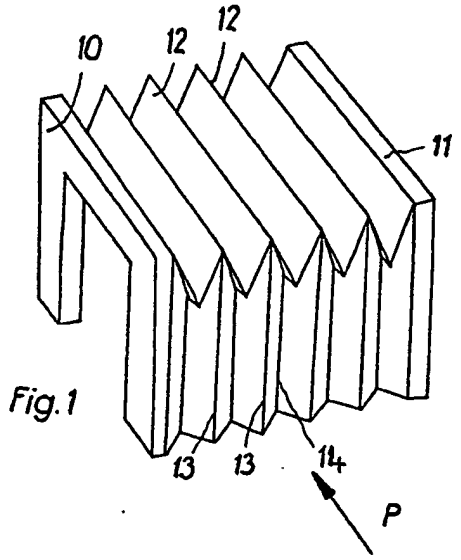

Fig. 1

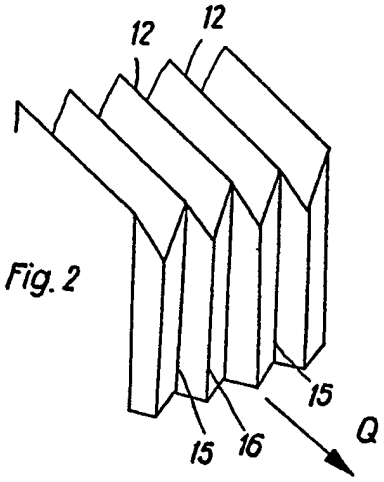

Fig. 2

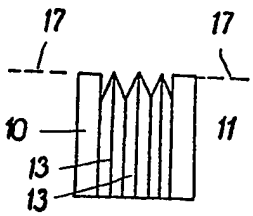

Fig. 3

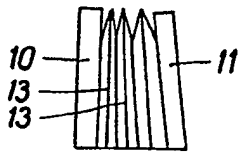

Fig. 4

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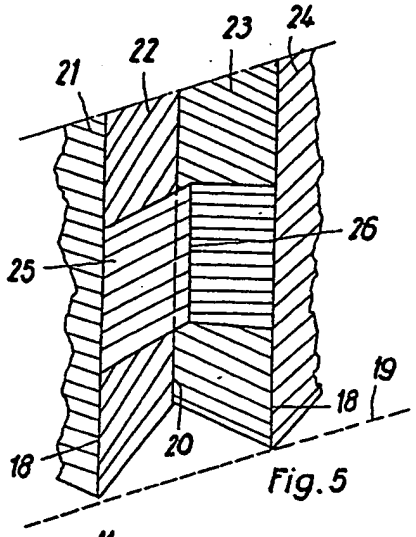


Fig. 5

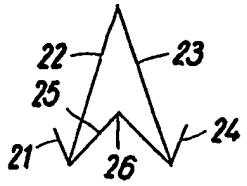
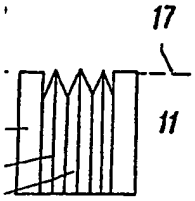


Fig. 6

Fig. 3



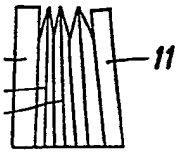
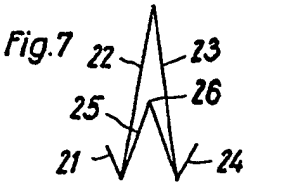


Fig. 4



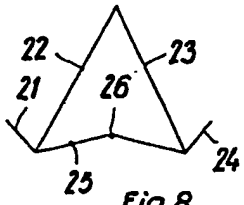


Fig. 8

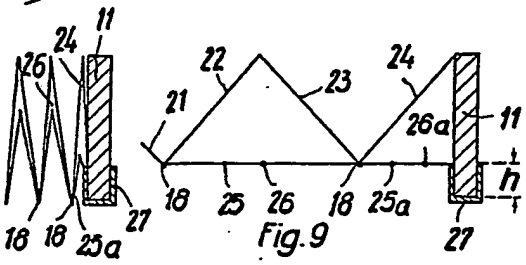


Fig. 10
Fig. 9

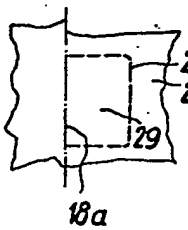


Fig. 11

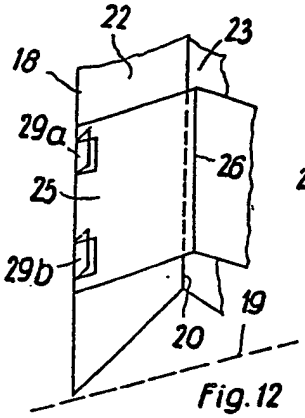


Fig. 12

Fig. 13

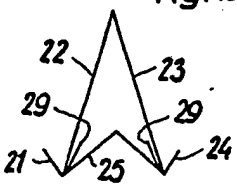
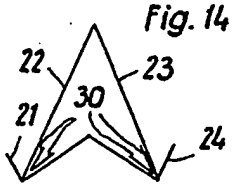


Fig. 14



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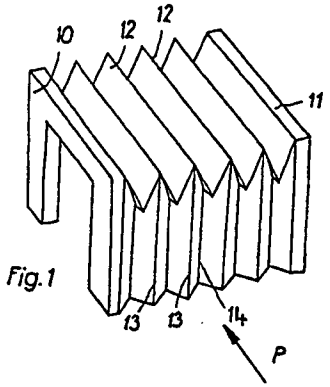

Fig. 1

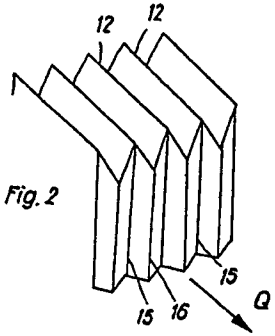

Fig. 2

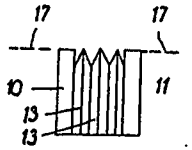

Fig. 3

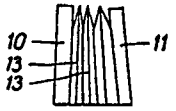

Fig. 4

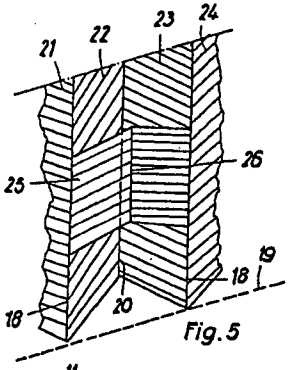

Fig. 5

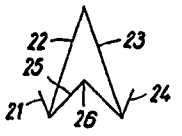

Fig. 6

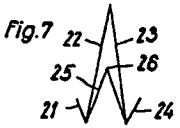

Fig. 7

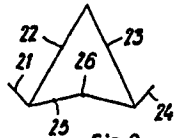

Fig. 8

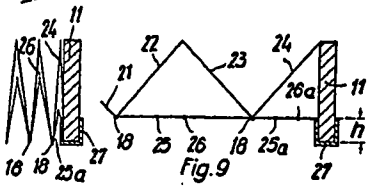

Fig. 10
Fig. 9

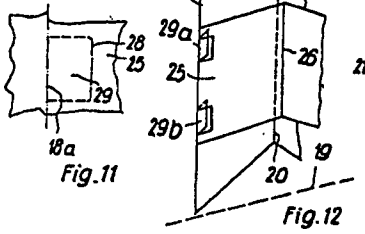

Fig. 11
Fig. 12

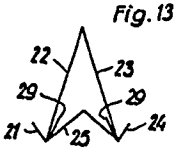

Fig. 13

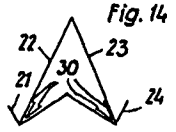

Fig. 14